



E/CONF.39/D/46

3 Oct.1962

ORIGINAL : ENGLISH

**UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS**

Agenda Item:D.6.1

United Arab Republic

**POSSIBILITIES OF PRODUCING VISCOSE,
RAYON AND NYLON FROM AVAILABLE LOCAL RAW MATERIALS
AND BLENDS WITH NATURAL FIBRES**

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POSSIBILITIES OF PRODUCING VISCOSE

RAYON AND NYLON FROM AVAILABLE LOCAL RAW

MATERIALS AND BLENDS WITH NATURAL FIBRES

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I INTRODUCTION

1. Production of man-made fibers on industrial scale started in the United Arab Republic in 1950 with the production of viscose rayon filaments which totalled 1870 tons per year and staple fiber of 1312 tons per year. In 1955 another establishment has started the production of viscose filament with 751 tons/year. Both companies have increased their production and together attained in 1961 an output of 6749 tons of continuous filament rayon, achieving an increase of 261% to 1950 production. Also the staple fiber production has increased reaching 4343 tons in 1961 with a 231% increase compared with 1950. The steps of this increase and its rate over such period of time are shown in Table 1 and illustrated in Figure 1.

2. Up to 1957 all viscose filaments and staple fiber production was satisfying most of the needs of the local market consumption. However, in 1957 exportation started with 1.5% in filament form and 11.3% in cloth form of the total production. These amounts increased year by year until they reached 23% of the total production for filamented yarn, 11.2% of viscose staple and 17.4% in cloth form. Table 1 also shows the imports and exports of the different forms of the rayon production.

3. As the viscose rayon production was based on imported cellulose pulp, increase in production meant an equivalent increase in the imported pulp as shown in Table 1. This fact encouraged research workers in the UAR to investigate the possibility of cellulose pulp production from the available local resources. Steps were also taken to increase the production of other chemicals such as caustic soda, sulphuric acid, carbon disulphide, etc., according to well defined plans which took account of the requirements of other industries as well.

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4. The continuous growth of the viscose rayon industry was accompanied by an increase in the importation of synthetic yarns and products, particularly Nylon. Accordingly, in 1957 it was decided to erect a plant for the production of Nylon 6 which was completed in 1958. It started with a production amounting to 34 tons per year of Nylon filament and 101 ton per year of nylon staple. By the end of 1961 these production figures were raised to 175 tons / year of filament and 144 tons per year of nylon staple. This represents an increase of product equivalent to 41.5% for the former and 42.5% for the latter.

5. At the present projects for expanding the existing nylon plant and for erecting other plants for the production of acrylic and polyester fibers are under investigation. These will be provided with intermediate for production from the new petrochemical plant.

II. LOCAL AVAILABLE RESOURCES OF RAW MATERIALS FOR VISCOSE RAYON

6. Practically all the main chemicals utilized in the manufacture of viscose rayon are now produced in the UAR. Wood-pulp is the only main raw material which is still imported. To render the industry independent a study of the local available resources for raw materials which could be utilised in the production of cellulosic pulp with specifications suitable for rayon production has been carried out. Obviously attention was given to natural cellulosic resources which could be used economically and in adequate amounts to satisfy the needs for a pulp suitable for viscose production. The materials that came under consideration, and were investigated are:

- | | |
|-------------------|--|
| a) Bagasse | d) Cotton Waste |
| b) Rice straw | e) Eucalyptus wood |
| c) Cotton linters | f) Reeds (<i>Phragmites communis</i>
and <i>Arunda donax</i>) |

III. RESEARCHES CARRIED ON THE ABOVE MATERIALS WITH THE OBJECT OF EXAMINING THEIR SUITABILITY FOR THE PRODUCTION OF VISCOSE PULP

7. The National Research Centre of the UAR, in cooperation with the Rayon Producers organized a research scheme to study the possibility of substituting the imported wood pulp for pulps produced from the previously enumerated raw materials. In the following, a summary is given of the main results obtained:

(a) Bagasse:

(1) Chemical researches (1) on bagasse showed that the pith part, which forms about 25% of the raw material, has lower cellulose content and higher ash content than the fibrous part. Consequently, investigations (2) carried out to study the amount of pith that ought to be removed to produce pulps suitable for viscose, stated that from 40% to 50% of the pith had to be removed. Also, various

methods of the removal of the pith had been studied (3) and different pulping procedures had been suggested in literature (4,5,6,7,8). The aim of the research (9) carried in the N.R.C. was to develop an easy and quick method for depithing bagasse and to estimate the minimum amount of pith which has to be removed, as well as to study a more suitable pulping method for the Egyptian bagasse, the analysis of which had been found as follows:

Hemicellulose	21.20%
Lignin	18.20%
Methanolbenzene	8.30%
Ash	1.98%

(11) The results of this investigation showed that only 3% of the prehydrolyzed material is necessary to be removed to reduce the ash content to suitable values. Further removal of the pith had no effect on reducing the ash or increasing the alphacellulose of the obtained pulp. Also, a new method for depithing of bagasse after prehydrolysis was developed and proved to be superior to the depithing before prehydrolysis in being easier, quicker, and leads to pulps higher in yields and with the same alphacellulose and ash content. Besides, it has been proved in this work that suitable viscose pulps can be prepared under atmospheric pressure and without any mechanical stirring by using no more chemicals and pulping times than the conventional prehydrolysis - alkali method under high pressure. The pulps obtained under atmospheric pressure delivered viscose of better filterability than those obtained under high pressure.

(b) Rice straw:

(1) Rice straw is characterized by its high ash and silica content amounting to about 20% and 15% respectively. Nitric acid pulping method, (10,11), applied to rice-straw produced pulps with high ash content ranging from 0.3% to 0.8%. Nevertheless, this process reduced the hemicellulose sufficiently to a value corresponding to that of commercial viscose pulps. Other investigators (12) applied a 2nd stage alkali cook to Egyptian rice-straw at different temperature ranging from 110°C to 170°C and duration between 3 to 4 hours, but pulps obtained were unsuitable for rayon grade.

(11) The results of research (13) carried at the N.R.C. showed that the high ash content of rice straw pulps is mainly attributed to the leaves. By complete elimination of leaves before prehydrolysis and pulping, bleached pulps with 0.11% ash, and 0.07% silica were obtained. Nevertheless, the leaves constitute about 65% of the raw material difficult to be completely removed mechanically. Most of the ash and silica of leaves are located in the epidermal cells which constitute a small part of the leave structure.

(111) These cells alone had been removed to a great extent without removing the other unobjectionable leaf cells by screening. This treatment caused a loss of the prehydrolyzed material corresponding to only 12% of the raw material, and resulted in the reduction of the ash and silica of the bleached pulps. Yet, the

ash and silica values were still unsuitable for viscose pulp. By applying moderate pulping conditions, especially short time periods at high temperature to the screened prehydrolysed material, the ash and silica of the pulps decreased and the yield increased considerably. The optimum pulping conditions were 150°C maximum temperature and for a pulping period of 1/4 hour.

(c) Cotton linters:

(i) Egyptian cotton linters had been considered as a possible source for chemical cotton for viscose rayon industry in Egypt. Its high ash content, as shown in Table 2, had proved always to be a major problem.

TABLE II.
CHEMICAL ANALYSIS OF RAW LINTERS

Moisture	%	8.35
Ash	%	3.39
Ash Alkalinity.....	%	19.69
Nitrogen	%	0.59
Ether extraction	%	1.24
Alcohol-benzene (1-2) extractives	%	1.95
Cold water extractives	%	2.34
Total extractives	%	5.53
Alpha cellulose	%	78.70
Beta and gamma cellulose	%	4.26
Pentosans	%	2.56

(ii) A series of experimental laboratory cooks (14) were made on the Egyptian cotton linters to find a suitable method for preparing purified linters of low ash and silica content, that can be used by the rayon industry. Caustic soda was used as the pulping agent under different conditions of alkali concentration, temperature and time. The unbleached and bleached purified linters were analysed for alpha cellulose, pentosans, extractives, ash and silica. Lowering the ash of the Egyptian linters was accomplished by subjecting the raw linters to a preliminary washing with a suitable commercial detergent followed by alkali digestion and bleaching. This gave satisfactory bleached Egyptian linters analysing:

Alpha cellulose	%	98.65
Pentesans	%	0.93
Extractions	%	0.13
Ash	%	0.09
Silica in ash	%	37.75
and D.P.	%	1519

(iii) Of interest in this study is that the lower alkali concentration was more beneficial in giving the optimum results than the higher and more expensive alkali concentration. The optimum results for alkali digestion for Egyptian linters was found to be 1.5% alkali concentration at 130°C for 6 hours. The final result showed that the Egyptian linters could be considered as a suitable raw material for the production of viscose rayon.

(d) Cotton waste "a" :

Cotton spinning waste is available in a considerable amount of about 10,000 tons per year. This figure is liable to further increase in the near future as a result of the fast increase in the volume of the cotton spun locally. This fact has drawn attention to this waste as a possible raw material for viscose pulp industry. Laboratory research (15) had been performed and the necessary treatments of the waste before its use had been laid down. Continuous filament rayon yarn was spun on the conventional system and preliminary physical tests showed promising results and render the project worth studying from the economical and industrial aspects.

(e) Eucalyptus wood "b" :

In this study (16) Eucalyptus restructa was investigated as a raw material for production of different grades of viscose pulp. The different pulping and refining processes were tested and good results were obtained.

(f) Reeds (Phragmites Communis):

(i) Chemically suitable viscose pulps were obtained (17) from Egyptian Phragmites communis by prehydrolysis-sulphate-pulping in both the laboratory and the pilot plant. The viscose solution of the phragmites pulp had similar properties as those of the viscose solutions prepared from commercial beechwood viscose pulps of the same disperse viscosity. Spinning trials were made with two different samples of viscose prepared from the experimental pulps. The resultant yarns compared favourably in mechanical and chemical properties with yarns obtained from commercial wood pulps.

(ii) In conclusion it is to be noted, that these researches and others of similar type had been carried out on experimental scale only and its application to industry had been delayed due to lack of pulping facilities particularly on a large scale.

(iii) Nevertheless, as a new factory for paper pulp manufacture is now in action which provides the necessary means for pulping, steps are now being considered to bring the results of these researches to the industrial level. Also, it has to be born in mind, that with the completion of the High Dam project, the quantity of the above mentioned agriculture raw materials will be increased by at least 30%.

IV. LOCAL AVAILABLE RESOURCES OF RAW MATERIAL FOR POLYAMIDES

8. Nylon is manufactured locally at present from imported caprolactam. A project for the production of this imported material

"a" At the present all cotton waste is consumed in producing condensed yarn.

"b" Eucalyptus wood cannot be considered as a potential raw material unless a scheme for planting forests on a suitable scale is put in action.

is included in the second five year plan. The production will be based on cyclohexane obtained from the proposed project for the petrochemical industry. Enough caprolactam to produce 1750 tons yearly of fiber is scheduled within this project. At the present time, Benzene or phenol will be considered as the starting material for the production either caprolactam for nylon 6 or adipic acid and hexamethylene-diamene for the production of nylon 66. There are several channels which might be utilized for the production of phenol.

- (i) Through future expansion of the coking plant which is under construction at Helwan. The production capacity of the plant will be at first 280,000 tons of coke, for the Iron and Steel Factory. The light oil will be a good source for benzene and from it phenol could be prepared. Incidentally we mention that a project for the production of dyestuffs and intermediates and based partly on crudes obtained from the light oil and tar of the above mentioned coking plant has been scheduled in the first five year plan and its erection will start this year.
- (ii) Through future developments in the petrochemical industry, the second five year plan made provision for establishing this industry in Egypt which will be based at first on existing light gasoline (120,000 tons). Future developments are possible and the production of benzene from n-hexane or from methycyclopentane are possibilities for the future which may lead to nylon 6 or nylon 66 as well as other synthetics such as polyesters "c" and acrylic fibers.
- (c) Agriculture waste materials such as corn cobs, wheat-straw or bagasse might be utilized for the production of furfural from which adipic acid and hexamethylene diamine may be synthesized (Nylon 66).
- (d) The fourth route which could be utilized is based on acetylene. The production of calcium carbide will take place at Asswan.

V. BLENDS

9. Blends offer innumerable advantages some of which are:

- (i) It is an important element in promoting fashion changes as consumers are tempted by the novelty or pleasing appearance of a textile on sale.
- (ii) Appropriate blending is an important element in producing fabrics of improved functionability.
- (iii) Staple fibers may be blended so that colour effects could be obtained in piece dyeing.

10. Though the statistical data of the amount of man-made fibers used in blends in the UAR is scanty, yet it seems that development in this direction compare favourably with development taking place

"c" Projects for the production of 350 tons of Polyester and 5000 of acrylic fiber yearly are under consideration. Both fibers will be manufactured from intermediates obtained from the petrochemical industries.

in other countries, consequently increased amounts of man-made fibers are being used each year in producing blends as shown in Table 3.

TABEL III.

CONSUMPTION IN SELECTED BLENDS OF IMPORTED
AND LOCALLY PRODUCED MAN-MADE FIBERS

<u>Year</u>	<u>Imported</u>	<u>Locally produced</u>
1959/60	80 tons	1016 tons
1960/61	87 tons	1040 tons

11. Undoubtedly, each producer applies his own efforts for investigations concerning the improvement of the qualities of the fibers he is producing, endeavouring to build up the fiber with optimum properties and maximum value. On the other hand, the blender has to spend more efforts with view of compromising between the different complex factors which govern to a great extent the quality and value of the blended fabric for the different end uses. In the UAR, efforts are being spent on locally produced as well as imported man-made fibers in studying their uses in blends. The following shows a composition of some blend mixtures which were found suitable for the suggested end uses (See Table 4).

12. Besides, the expected local production of other man-made fibers in the near future will widen the scope of blends in this country. In particular the production of the artificial wool (acrylic fiber) will provide new material that may partly replace wool as it is most appropriate for our climatic conditions and will be available at comparatively low prices.

13. Also, in addition to the different end uses of nylon staple fibers in other countries, this fiber has found a new market in the UAR, namely the manufacture of press cloth for cotton seed oil production. Usually, this cloth is manufactured from nylon tow and a large number of trials were made to substitute the imported tow by the locally manufactured nylon staple fiber. Also, the 100% nylon carpet is produced successfully in this country to replace the most expensive pure wool carpets.

14. However, the practical difficulties in processing fiber blends are encountered within spinning, preparation and weaving. Difficulties of even more complex nature are faced with in dyeing and finishing. Yet, all these difficulties are more or less associated with the intrinsic fiber properties. In order to achieve any progress in overcoming these difficulties a great deal of research is needed. For this reason as well as solving other problems encountered in the different branches of the textile industry, the need for a textile research institute is most urgent. The foundation stone of this Textile Research Institute will be laid down this year.

TABLE IV
BLENDS AND ITS END USES

Percentage of Fibers in Blend	End - Uses
34% C., 33% V., 33% A. 50% V., 50% A., 67% V., 33% A.	Popular fabrics for summer suitings
35% C., 65% P. 55% P., 45% W. 75% W., 30% A. 65% P., 35% V.	Men's tropical summer suitings
45% W., 40% V., 15% N. 50% W., 50% V.	Popular winter men's suitings
70% V., 30% W.	Ladies' wear
88% W., 12% N. 80% W., 20% N.	Uniform fabrics, socks and pullovers
75% W., 25% N.	Knitting yarn
90% W., 10% V. on woollen system	Ladies' overcoat and suits

C = Cotton A = Acetate W = Wool
V = Viscose P = Polyester N = Nylon

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TABLE (1) IMPORTS, EXPORTS AND LOCAL PRODUCTION OF VISCOSE RAYON AND NYLON AND ITS FUNDAMENTAL RAW MATERIALS (IN KILOGRAMS)

YEAR	IMPORTS					EXPORTS				LOCAL PRODUCTION			
	CAUSTIC SODA & LYE	WOOD PULP	VISCOSE RAYON			NYLON ARTICLE	CAUSTIC SODA & LYE	VISCOSE RAYON			CON. FIL. YARN	STAPLE FIBRE	CON. FIL. YARN
			YARN & THREAD	STAPLE FIBRE	FABRIC ARTICLE			YARN & THREAD	STAPLE FIBRE	FABRIC ARTICLE			
1950	13913	3437	2472	6056	1237	—	23	—	—	—	1870	1312	—
1951	13411	4876	2585	2465	1202	—	5	—	—	—	2315	2200	—
1952	14283	4318	1674	595	693	—	3	—	—	—	2299	1699	—
1953	13872	5519	2325	419	463	—	2	—	—	—	2540	2570	—
1954	17727	6908	1810	837	276	—	5	—	—	—	3433	2963	—
1955	24271	8837	1733	833	194	13	—	51	—	—	4592	3590	—
1956	21848	9217	1771	646	107	14	—	60	—	1699	5087	3447	—
1957	38035	9656	359	507	40	2	—	96	—	1040	5492	3449	—
1958	19385	10578	217	229	26	—	—	74	—	702	5692	4084	101
1959	32038	12097	153	358	19	—	—	384	—	1163	6081	5120	53
1960	36118	11928	167	730	22	—	—	269	—	1312	6610	4434	61
1961	28613	11979	29	577	5	—	—	431	—	1024	6749	4343	175

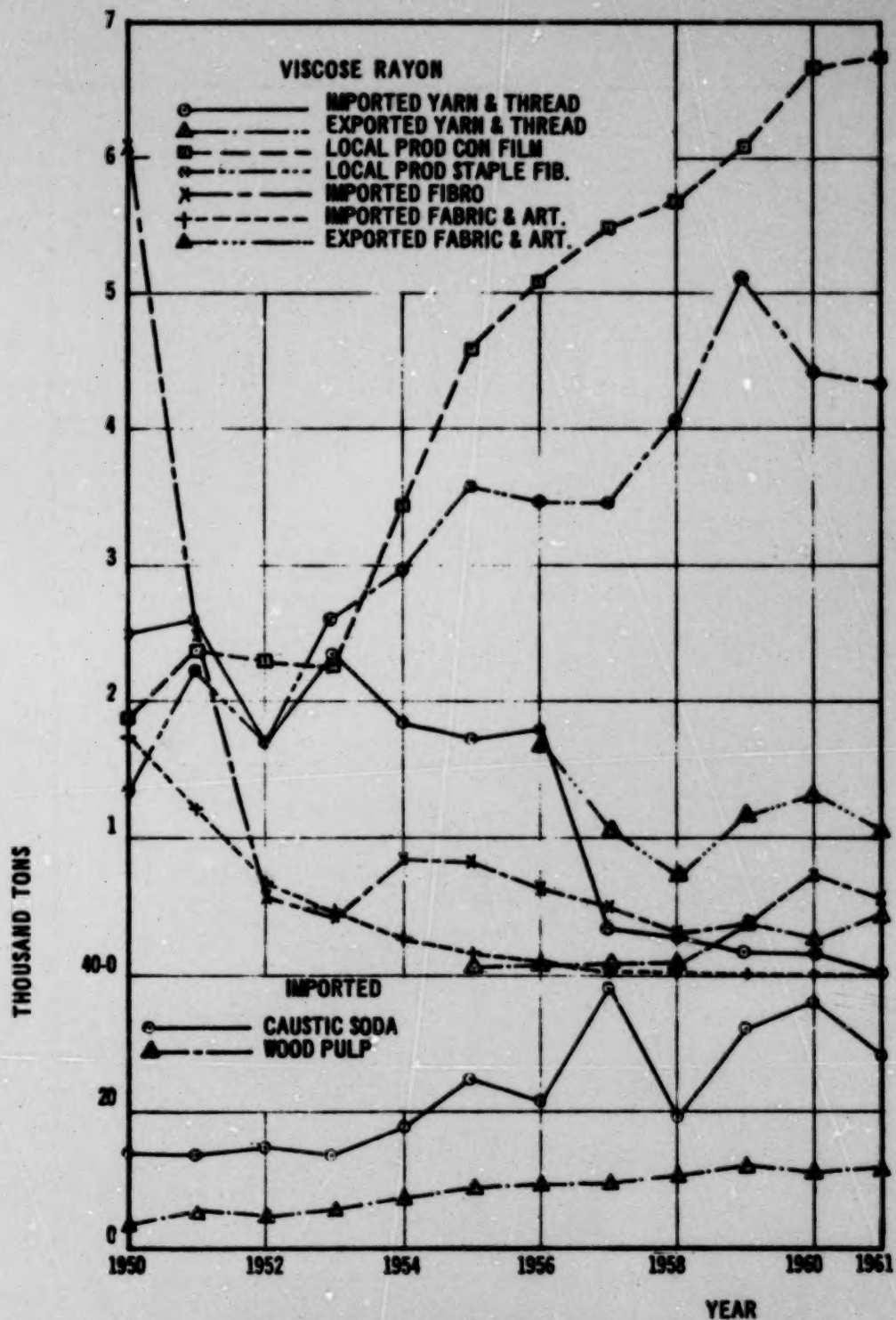


FIG. I IMPORTS AND EXPORTS OF VISCOSE RAYON AND RAW MATERIALS

